# Is Supersize More than Just Too Much Food?

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Diabetes and obesity are two of the most significant public health issues of our day, and both are major epidemics in the United States and abroad. These conditions are interrelated; obesity has been long recognized as a common precursor to adult-onset (type 2) diabetes, although "adult-onset" is becoming an outdated term. In the United States, the prevalence of obesity among children and adolescents has almost tripled since 1980, and an estimated 12.5 million children and adolescents (16.9%) are considered obese (Ogden and Carroll 2010). This trend is also apparent in preschool children 2–5 years of age, a group in which obesity increased from 5% in 1976–1980 to 10.4% in 2007–2008 (Ogden and Carroll 2010). One report based on well-child visits at a health maintenance organization in Massachusetts was particularly disturbing: The prevalence of overweight in infants 0–6 months of age almost doubled between 1980 and 2001, from 3.4% to 5.9% (Kim et al. 2006). This finding suggests that factors other than changes in physical activity or diet are contributing to these trends, pointing to possible changes in fetal programming.

The most recent estimates of diabetes prevalence in the United States are equally staggering. Based on data from 2005 through 2008, 25.6 million (11.3%) of all people in the United States ≥ 20 years of age have diagnosed or undiagnosed diabetes (Centers for Disease Control and Prevention 2011). Another 35% have prediabetes, a condition in which blood glucose is higher than normal but not high enough to be classified as diabetes. People with prediabetes have an increased risk of developing type 2 diabetes, heart disease, and stroke.

Being overweight or obese has been estimated to account for approximately 70% of the cases of type 2 diabetes (Eyre et al. 2004). However, the etiology of the remaining 30% is unknown. Given the sheer numbers of people with the disease—now estimated globally at 220 million and expected to grow to 366 million by 2030 (World Health Organization 2011)—it is easy to understand the growing consideration of "nontraditional" risk factors (e.g., environmental chemicals, stress, microbiome) as contributors to these diseases. A growing scientific literature implicating a role for environmental chemical exposures has been developed largely through the funding of the National Institute of Environmental Health Sciences (NIEHS) as part of the institute's broader interest in understanding endocrine-related disorders and the developmental origins of adult disease. Endocrine-disrupting chemicals alter control of adipose tissue development and function, control of food intake, insulin sensitivity, glucose homeostasis, and lipid metabolism (Janesick and Blumberg 2011; Nadal et al. 2009; Thayer et al. 2012). If the exposure occurs during development, the result could possibly be an altered "set point" or sensitivity for developing obesity or diabetes later in life.

Research addressing the role of environmental chemicals in diabetes and obesity has rapidly expanded in the past several years. Both the May 2010 White House Task Force on Childhood Obesity (2010) and the 31 March 2011 *Strategic Plan for NIH Obesity Research* [NIH (National Institutes of Health) Obesity Research Task Force 2011] acknowledge the growing science base in this area and cite the need to understand more about the role of environmental exposures as part of future research and prevention strategies.

To help develop such a research strategy, the National Toxicology Program (NTP), with collaboration from the NIEHS intramural and extramural program scientists, organized a state-of-the-science workshop in January 2011 titled "Role of Environmental Chemicals in the Development of Diabetes and Obesity." The technical background documents assembled for this workshop were extensive, totaling > 500 pages and spanning the range from epidemiological data to high throughput screening results. As an additional scientific resource, approximately 800 main findings from the epidemiological studies of diabetes and childhood obesity have been compiled into a searchable graphing software program. A diverse group of > 150 scientists, including toxicologists, epidemiologists, and bioinformaticists, as well as experts in the pathobiology of diabetes and obesity, attended the meeting to review the existing literature and shape a research strategy.

The review of the collected literature supported the plausibility of certain environmental chemicals acting as "obesogens" or diabetogenic agents. In some cases, the conclusions were based on surprisingly consistent epidemiological associations. With other chemicals or chemical classes, consistency was found in mechanisms of action. We have little appreciation for the extent to which environmental chemical exposures may be influencing obesity and diabetes rates, but it is becoming increasingly clear that overnutrition and a lack of exercise are not the entire story.

The first of a series of articles stemming from the January 2011 workshop appears in this issue of *Environmental Health Perspectives* (Thayer et al. 2012). Kristina Thayer, director of the NTP Office of Health Assessment and Translation, other NIEHS staff, and the workshop chair, Michael Gallo (University of Medicine and Dentistry of New Jersey–Robert Wood Johnson Medical School) provide an introduction to the topic and an orientation to the workshop and key outcomes. Upcoming reports will examine the influence of smoking during pregnancy, as well as nicotine and arsenic exposures, on diabetes and obesity outcomes and mechanisms.

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## References

Centers for Disease Control and Prevention. 2011. Diabetes Data & Trends. Available: http://apps.nccd.cdc.gov/DDTSTRS/default.aspx [accessed 12 December 2011].

Eyre H, Kahn R, Robertson RM. 2004. Preventing cancer, cardiovascular disease, and diabetes: a common agenda for the American Cancer Society, the American Diabetes Association, and the American Heart Association. CA Cancer J Clin 54(4):190–207.

Janesick A, Blumberg B. 2011. Minireview: PPARγ as the target of obesogens. J Steroid Biochem Mol Biol 127(1–2):4–8.

Kim J, Peterson KE, Scanlon KS, Fitzmaurice GM, Must A, Oken E, et al. 2006. Trends in overweight from 1980 through 2001 among preschool-aged children enrolled in a health maintenance organization. Obesity (Silver Spring) 14(7):1107–1112.

Nadal A, Alonso-Magdalena P, Soriano S, Quesada I, Ropero AB. 2009. The pancreatic β-cell as a target of estrogens and xenoestrogens: Implications for blood glucose homeostasis and diabetes. Mol Cell Endocrinol 304(1–2):63–68.

NIH Obesity Research Task Force. 2011. Strategic Plan for NIH Obesity Research. NIH publication no. 11-5493. Available: http://www.obesityresearch.nih.gov/about/strategic-plan.aspx [accessed 12 December 2011].

Ogden C, Carroll M. 2010. Prevalence of Obesity among Children and Adolescents: United States, Trends 1963-1965 through 2007-2008. Available: http://www.cdc.gov/nchs/data/hestat/obesity_child_07_08/obesity_child_07_08.htm [accessed 12 December 2011].

Thayer KA, Heindel JJ, Bucher JR, Gallo MA. 2012. Role of environmental chemicals in diabetes and obesity: a National Toxicology Program workshop review. Environ Health Perspect 120:779–789.

White House Task Force on Childhood Obesity. 2010. Solving the Problem of Childhood Obesity Within a Generation: White House Task Force on Childhood Obesity Report to the President. Available: http://www.letsmove.gov/sites/letsmove.gov/files/TaskForce_on_Childhood_Obesity_May2010_FullReport.pdf [accessed 12 December 2011].

World Health Organization. 2011. Diabetes Programme: Facts and Figures about Diabetes. Available: http://www.who.int/diabetes/facts/en/ [accessed 12 December 2011].


# Methylmercury Effects and Exposures: Who Is at Risk?

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Two articles in this issue of *EHP* represent recent syntheses of research on the effects of mercury exposure from fish consumption: Karagas et al. (2012) reviewed the emerging research on health effects of low-level exposures to methylmercury (MeHg), and Oken et al. (2012) summarized the complexities of providing clear and uniform fish consumption advice to reduce MeHg exposure while balancing nutrient intake, ecologic concerns, and economic issues. These two papers emerged from workshops convened in September 2010 and July 2011 by the Coastal Marine Mercury Ecosystem Research Collaborative (C-MERC) and sponsored by the Dartmouth Superfund Research Program and its partners. C-MERC brought together a group of 50 scientists and stakeholders to work jointly to gather and analyze existing data and to publish synthesis papers on the fate of mercury from its environmental sources to seafood consumers—issues of critical importance for informing public policy.

Mercury, particularly its organic form (MeHg), is a global contaminant and toxicant of major concern for humans and wildlife (Driscoll et al. 2007; Fitzgerald et al. 2007; Grandjean et al. 2005; Mahaffey et al. 2009). Mercury is third (after arsenic and lead) on the 2011 Agency for Toxic Substances and Disease Registry (ATSDR) priority list of 275 hazardous substances (ATSDR 2011), which includes substances that present the most significant potential threats to human health in the United States. MeHg has long been known as a potent neurotoxicant, particularly due to incidents of acute and high-level exposures (e.g., Minimata, Japan; Iraq), but neurological effects have been documented in island populations that consume large quantities of marine mammals or seafood (Axelrad et al. 2007; Cohen et al. 2005; Rice 2004). Moreover, recent epidemiologic studies have revealed evidence of a range of health effects in adults and children at MeHg exposure levels lower than previously observed (Lynch et al. 2010; Mergler et al. 2007; Oken et al. 2008). In this issue of *EHP*, Karagas et al. (2012) provide a comprehensive review of the current scientific evidence for effects of low-level exposures to MeHg on birth outcomes, neurocognitive outcomes, the cardiovascular system, and immune function. The authors recommend that future studies investigate sex-specific effects and genetic susceptibility, and that they include more precise exposure indicators, outcome measures with mechanistic bases, and consideration of nonlinear dose–response relationships. Their review helps to set the stage for future research on the human effects of low-level MeHg exposure.

Fish are the most important agents of MeHg exposure for humans, and consumption of contaminated fish is a serious public health concern (Mahaffey et al. 2009; Oken et al. 2005; Sunderland 2007). Currently, all 50 U.S. states have fish advisories for inland and coastal waters, and states on the Atlantic coast, as well as Alaska and Hawaii, have statewide coastal advisories [U.S. Environmental Protection Agency (EPA) 2010]. Consumption of marine fish and shellfish is the primary means of human exposure to MeHg; approximately 92% of the global fish and shellfish harvest for human consumption is marine [United Nations Development Programme, United Nations Environment Programme (UNEP), World Bank, and World Resources Institute 2003], with the majority coming from coastal fisheries (Food and Agriculture Organization of the United Nations 2010). Most people trying to reduce MeHg exposure risk do so through their choices in buying and eating seafood. Oken et al. (2012) discuss the wide range of trade-offs facing fish consumers and the difficulties in evaluating current fish consumption advice. Consumers need to consider not only the contaminant concentrations in fish but also their nutritional value, the sustainability of the fishery, and the cost of different fish choices. Moreover, there is little guidance for specific subpopulations with different exposure risks due to factors such as age or baseline intake of fish. The authors recommend that fish consumption advice address these multiple perspectives and provide a clear and simple message. Ultimately, fish consumption advice should protect public health on a global scale and promote sustainability of the world's fisheries as a critical source of human nutrition.

Currently, important national and international policy decisions are being made concerning the environmental impacts of mercury. The widespread threat to human health posed by MeHg has prompted the United States to pass a mercury rule for controlling atmospheric emissions (U.S. EPA 2011) and the UNEP to forge a broad consensus